

Level 5: Invention

Summary

Grade Level: 6-8

Teaching Time: Two 45-minute periods

Design Your Own Investigation

Level 5 is an important student-driven interactive learning experience that can be used to measure student progress. This last level provides an opportunity for students to apply their acquired monitoring and mapping skills, and their coral content knowledge, to a real coral bleaching identification project. Students will pick a coral reef location on the planet, list the time frame in which they will examine coral health, and make a prediction based on SST time series observations as to whether their chosen location is experiencing coral bleaching over time.

Objective

- Students will design their own investigation using real data to try to answer a research question of their choosing. Their research question will serve as the Focus Question for this level. Their study will be based in one of several suggested coral reef locations.

Climate Literacy

Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth (CL 4d)⁸.

Background (Teacher)

At this level middle school students are ready to use the authentic learning environment of coral reefs and real data to monitor actual coral bleaching events as indicators of what is happening to the health of coral reefs in the world's oceans. They will also be challenged to think about the importance of coral reefs to them personally.

⁸ *Climate Literacy: The Essential Principles of Climate Science*, Second Version: March 2009. <http://www.globalchange.gov/browse/educators>

Students are ready to move beyond interpreting a single selected coral bleaching site to examining coral reefs as an interactive system on the planet. Students many times do not recognize the differences between parts of an individual coral reef and coral reefs as a total system. Individual students will access and manipulate data regarding a coral reef site of their choosing, and then all students will join their coral reef studies together to look at coral reefs as a system within the world's oceans.

Activity 5: Designing Your Own Investigation

Materials

- **Student Master 5.1: Citizen Scientist Researchers - Design Your Own Investigation** (1 per student)
- **Student Master 5.2: Data Log Sheet** (1 per student)
- **Computer with an Internet connection**
- **NOAA Coral Reef Watch Virtual Stations website**

Students will design and conduct a scientific investigation using real data to answer a research question of their choosing. They will use appropriate tools and techniques to gather, analyze, and interpret data. Based on their experience, students will then communicate their scientific procedures and findings.

Preparation

This activity can be assigned to individuals or to teams of two students. To assist students, focus their investigation on one of the suggested student projects below.

- Determine whether there is evidence of coral bleaching at a location of the student's choice; or
- Determine whether there is evidence of coral bleaching near the Hawaiian Islands.

Note: Examine the NOAA Coral Reef Watch Virtual Stations website, which links to graphs and monitoring stations before students use this tool to pick a coral reef site. A link to the NOAA Coral Reef Watch Virtual Stations website can be found in Level 5 of the Coral Bleaching module at datainthe classroom.noaa.gov.

The Virtual Stations map shows coral reef locations worldwide. When you click on a station site, an information box will display a summary of conditions in that area. This tool will help students make a free choice of reef locations for their research.

Procedure

1. Distribute **Student Master 5.1: Citizen Scientist Researchers - Design Your Own Investigation** and **Student Master 5.2: Data Log Sheet**.

Review with students **Student Master 5.1: Citizen Scientist**

Researchers – Design Your Own Investigation and tell students they are going to design and carry out their own individual research project on coral reef health. First, they will need to pick a coral reef site to research. Project the NOAA Coral Reef Watch Virtual Stations website and show students how the website can be used to select coral locations and other information around the planet.

2. Meet with students to assist them in developing a good research question that can be tested using available data. The questions below can help students formulate their question.

- Is there evidence for a coral bleaching event or stress at your chosen location this year?
- Has there been evidence for coral bleaching or stress at your chosen location in the past?

Note: If students are having trouble formulating a research question, you may wish to refer them back to the research question they used in Activity 4: Did the duration and intensity of changing water temperature affect coral health at your site?

3. Guide and approve the student selection of a coral reef location using the online NOAA Coral Reef Watch Virtual Stations map or a listed Hawaii location. Help students use the tool to answer the following questions.

- Where is your selected site or location?
- Over what time period will you observe the selected coral reef?
- What is your predicted answer to your research question? Your predicted answer to your research question is your hypothesis.

4. Have each student or team follow the steps under Plan Your Investigation and Conduct Your Investigation on **Student Master 5.1** to develop a plan for a research project that will answer their research question. The plan should include:

- A research question (developed in step 2)
 - A testable hypothesis that addresses the research question (developed in step 3)
 - A list of additional information needed
 - A list of data that will be collected to provide evidence for their hypothesis
5. Have students follow the steps on **Student Master 5.1** to go online and get their data.
 6. Remind students to use **Student Master 5.2: Data Log Sheet** to record the data products they select and examine.
 7. Have students choose a method to analyze their data. (Some possibilities are organize a table, generate maps or graphs, or answer questions.)
 8. Have each individual or team draw conclusions from their investigation.
 9. After students complete their research, have them follow the steps under Report Your Coral Health Findings on the master to organize, prepare, and present their findings to the class. Their use of the NOAA Coral Reef Watch Virtual Stations site, showing their individual coral site, should be part of their presentations.
- Note:** Project the Virtual Stations website image as a background to the student presentations (see top of **Student Master 5.1**). The goal is for students to see their selected coral sites as part of a total coral reef system, the health of which is being affected by rising sea surface temperatures.
10. Encourage students to understand the importance of coral reefs around the world. Have individuals or teams compare and contrast their coral reef observations and data with other teams' findings from different locations. Remind them to include examples of maps, graphs, and other data.

11. Use student presentations as an opportunity to relate student investigations about coral bleaching to the debate about global climate change. Conduct a discussion around the questions at the bottom of **Student Master 5.1**:

- Do you think the susceptibility of corals to temperature changes may result in coral bleaching or a decrease in coral health at your location? Give examples.
- Why is it important to study coral reef health by comparing past reef with present reef conditions?
- Is your coral reef location part of a total system of corals? How do you think rising sea surface temperature is changing the coral reef system?
- As a Citizen Scientist Researcher, why is it important for you to care about rising sea surface temperature globally, and the health of coral reefs related to a changing climate?
- Answer the Big Question for your study of coral reefs: What are the consequences of rising sea surface temperature, and why should you care?

Student Master 5.1

Citizen Scientist Researchers - Design Your Own Investigation



Hello Citizen Scientist Researchers:

Join oceanographers, marine biologists, climatologists, and all of those who have enjoyed the experience of coral reefs in understanding why they are important to our future lives on the planet.

NOAA's Coral Reef Watch notes that, in many ways, coral reefs directly benefit the nations where they occur. They provide a huge economic benefit: recreation and commercial fishing on coral reefs generate billions of dollars each year for local economies. Reefs also act as a natural barrier, a first line of defense in protecting tropical coasts from storms and floods. Scientists are only beginning to explore the range of potential medicines that reef organisms can provide, including cancer treatments, painkillers, sunscreen, and antivirals. But even more importantly, coral reefs host some of the greatest biodiversity on the planet. Coral reefs are a vital and threatened natural resource.

You have explored the need to compare past coral health with present coral health to measure if changes are taking place related to rising sea surface temperature (SST). Why is this important? Researchers believe that coral reefs are sensitive to changes in ecosystems and can show some of the first signs of how rising SST is affecting our planet's future.

The Big Question for your study of coral reefs is: What are the consequences of rising sea surface temperature, and why should you care?

Now it's your turn to help investigate the health of coral reefs worldwide. Choose a coral reef to study, looking at coral health past and present in order to predict the future. Let's get started!

Pick a Coral Reef Location

Travel online to NOAA's Coral Reef Watch Virtual Stations website. Follow the directions below:

1. What reef site would you like to study? _____
2. Where is this coral reef site located? Latitude: _____ Longitude: _____
3. You will collect data for at least three years, using your first year as a baseline. What are the day, month, and year of each data collection?

Year 1: _____ Year 2: _____ Year 3: _____

List any additional years: _____

Plan Your Investigation

Develop a research question you would like to explore about the past and present health of the coral reef you selected. Then form a hypothesis that helps answer that research question. Check with your teacher to approve your question.

Research Question: _____

Hypothesis: _____

Conduct Your Investigation

1. Design a plan to test your hypothesis and answer the research question.

What do you need to get started?

- a. More information: Do you need more information about changes in temperature over time and how long the temperature stayed at a high level?
- b. Specific data: When you go online to collect data, how many of the following maps and graphs will you generate?
 - SST map
 - Coral bleaching DHW map
 - Coral bleaching DHW time series graphs

Hint: You should download one time series graph for each date you observe at your coral reef site.

2. Go online and get the data using the following steps:
 - a. Visit www.datainthe classroom.noaa.gov, and find the Coral Bleaching module.
 - b. Follow the link to "Get Data."

- c. Using the controls on the left side of the map, pan and zoom out until the map displays the area immediately around the site you are studying.
 - d. Select the dataset you wish to access under "Which dataset?"
 - e. Select either "Map" or "Time series graph" on the menu labeled "Which view?"
 - f. Using the form, specify a date or date range.
 - g. Click the "Get Data" button.
 - h. Save the graph to your computer. On a PC, right click with the mouse and select "Save as..." On a Mac, hold down the Ctrl key and click with the mouse.
3. Record the data you select and/or save it on the **Student Master 5.2: Data Log Sheet**, and save images to your computer so you can refer to them later for data analysis and to show your classmates when you present your findings.

4. Analyze the data by answering the following questions:

What are the conditions at your reef site for each year observed?

Hint: Look at time series graphs of SST to get a sense of the temperature range at this site.

Were corals at risk for thermal stress?

Look at false-color maps of degree heating weeks. Look for areas with DHW values above zero.

Hint: Check the DHW number at the top right of the map for a data point.

How high did the DHWs get?

Hint: Look at time series graphs of DHW for the area. If the DHW value gets above 4°C, you should expect to see significant coral bleaching. Values above 8°C indicate that you can expect severe coral bleaching mortality.

5. From your observations of each year's data, can you tell if your reef is/was at risk for coral bleaching? Give evidence.

6. Draw conclusions about your data.

Comparing data sets for each year you observed, would you conclude that your reef is/was under stress?

Hint: Look at your maximum DHW figures/maps. DHWs measure the accumulated thermal stress on the reef. The maps/figures show the maximum DHW values experienced during each year of your in situ monitoring.

How did thermal stress compare at each year's monitoring?

How did the severity of coral stress or bleaching compare at each year's monitoring?

Write down what you learned from your investigation of coral reef health. Use your data to help you decide if your hypothesis is supported. If your hypothesis is not supported, think about other data you might need to collect.

Report Your Coral Health Findings

All researchers need to publish and present their findings to their peers.

1. Your first step is to combine the data you collected to see if it tells the story of your coral reef's health.
2. The next step is to share your findings with your classmates. Use your collected data, vocabulary words, reef images, and the NOAA Coral Reef Virtual Stations website as part of your report.
3. Include the maps and graphs that you generated as part of your report, and highlight key information for each year so you can easily compare one year to another.

Discuss Conclusions

Discuss the following questions with your team partner or team up with students who investigated different locations:

- Do you think the susceptibility of corals to temperature changes may result in coral bleaching or a decrease in coral health at your location? Give examples.
- Why is it important to study coral reef health by comparing past reef with present reef conditions?
- Is your coral reef location a part of a total system of corals? How do you think rising sea surface temperature is changing the coral reef system?
- As a Citizen Scientist Researcher, why is it important for you to care about rising sea surface temperature globally, and the health of coral reefs related to a changing climate?
- Answer the Big Question for your study of coral reefs: What are the consequences of rising sea surface temperature, and why should you care?

Student Master 5.2

Data Log Sheet

As you use the online data access form to select data about coral reef health and possible coral bleaching, keep a record of the parameters you select on this data log sheet. Your data log will help you remember and keep track of the data you have looked at. Remember to save the maps and graphs to your computer so that you can access or print them later. The first row is presented as an example.

	Data Set	Map or Graph?	Region	Date (s)	Notes
1	DHW	Map	18-28° N Latitude 80-73° W Longitude	Sep 2, 2005	Max DHW = 9°C-weeks